Chapter5 Calculation of Intra-Industry Trade Index : A Comparison of East Asia and the EU

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FUKAO Kyoji and ISHIDO Hikari

As economic integration in East Asia progresses, trade patterns within the region are displaying an ever-greater complexity: Though *inter*-industry trade still accounts for the majority, its share in overall trade is declining. Instead, *intra*-industry trade (IIT), which can be further divided into horizontal IIT (HIIT) and vertical IIT (VIIT), is growing in importance.

In this chapter, we set out to measure and examine vertical intra-industry trade patterns in the East Asia region and compare these with the results of the EU.

1. Two Kinds of IIT Indices

Recent studies on intra-industry trade (IIT) have brought to light rapid increases in vertical IIT, i.e. intra-industry trade where goods are differentiated by quality.[2] Commodities of the same statistical group but of different quality may be produced using different mixes of factor inputs. Moreover, developed economies may export physical and human capital-intensive products of high-quality and import unskilled labor-intensive products of low quality from developing economies. Through this mechanism, an increase in vertical IIT may have a large impact on factor demands and factor prices in Japan and elsewhere.

First we consider Grubel-Lloyd Intra-Industry Trade Index ([1]) as defined as:

$$(1) \qquad (1-\sum_{j}\frac{|M_{kk'j}-M_{k'kj}|}{M_{kk'j}+M_{k'kj}})\times 100$$

where $M_{kk'j}$: value of economy k's imports of product j from economy k', $M_{k'kj}$: value of economy k'' s imports of product j from economy k. Although this index is convenient for its east of computation, it has the flaw of being unable to distinguish between horizontal IIT and vertical IIT.

In order to distinguish between horizontal and vertical IIT we adopt a methodology used by major preceding studies including [10]. The methodology is based on the assumption that the gap between the unit value of imports and the unit value of exports for each commodity reveals the qualitative differences of the products exported and imported between the two economies.

We break down the bilateral trade flows of each detailed commodity category into the three patterns: (a) *inter*-industry trade (one-way trade), (b) *intra*-industry trade (IIT) in horizontally differentiated products (products differentiated by attributes), and (c) IIT in vertically differentiated products (products differentiated by quality); where $UV_{kk'j}$: average unit value of economy *k*'s imports of product j from economy *k'*, $UV_{k'kj}$: average unit value of economy *k'*s imports of product j from economy *k*.. Then the *share* of each trade type is defined as: where *Z* denotes one of the three intra-industry trade

$$(2) \qquad \frac{\sum_j (M^Z_{kk'j} + M^Z_{k'kj})}{\sum_j (M_{kk'j} + M_{k'kj})} \times 100$$

types, i.e., "One-Way Trade" (OWT) "Horizontal Intra-Industry Trade" (HIIT) and "Vertical Intra-Industry Trade" (VIIT) as in Table 1.

For our analysis, we chose to identify horizontal IIT mainly by using the range of relative export/import unit values of 1/1.25 (i.e., 0.8) to 1.25. Although the adoption has these threshold values have no theoretical underpinning, the robustness of results in general are ensured in the existing literature (e.g., [5]).

2. Data for the Analysis of IIT

We used two sets of trade statistics in this chapter. For the analysis on trade patterns in East Asia and the EU we used the PC-TAS (Personal Computer Trade Analysis System) published by the United Nations Statistical Division. This dataset provides us with bilateral trade data of almost all the countries at the 6-digit HS88 commodity classification (Harmonized Commodity Description and Coding System Revised in 1988)for the years 1996 to 2000.[8] For the calculation of the IIT measures, we used the importing countries' data.

We should note several drawbacks of the PC-TAS data. First, because of the lack of data on trade volumes, we were unable to decide the trade patterns (OWT, VIIT, and HIIT) for many commodities. Therefore the coverage of commodities used for our analysis is not high.[10] Second, in the compilation process of the PC-TAS, trade data of less than 50,000 US dollars are excluded.[11] If we do not make adjustment for this cut-off procedure, our estimation of OWT shares will be biased upwards. For this reason, we did not use trade data of commodities where the import value was not recorded for one of the pair countries in the PC-TAS.[12] Third, trade data for Taiwan are not included in the PC-TAS.

3. Stochastic Treatment of Data in Computing IIT Indices

In the computation of IIT indices, the issue of how to treat what is so called "outliers" or anomalous data should be addressed. There are of course several factors we should take into consideration when we encounter anomalous data. In the case of computing unit-price ratio ($UV_{kk'j}/UV_{k'kj}$), we also encounter a large variance, due to economic factors as well as simple statistical errors in the data compilation process. Given all these factors, the diversity in the realized value of unit-price ratio can be treated as a stochastic process. Hence, viewing unit-price ratio $UV_{kk'j}/UV_{k'kj}$ as a stochastic variable x, we assume that x is subject to the following discrete time-series equation:

$$(3) \qquad x_{t+1} = b_t x_t$$

where x_{t+1}: realization in year t+1, x_t: realization in year t, b_t: randomly fluctuating positive coefficient.

It is known in the probability literature (e.g., [11]-[22]) that when the coefficient b_t is not constant and fluctuates as a random variable (with mean 0 and infinite variance), then the rank-size plot of x_t in a log-log scale exhibits the linearity property. Assuming ergodicity, i.e., the equal treatment of the time-series mean and the assembly (cross-sectional) mean, this linearity is expected to hold for cross sectional data subject to (3).

As Figure 1 shows, the scatter-plot (in a log-log scale) of $UV_{kk'j}/UV_{k'kj}$ using the case of Japan's trade with the rest of the world in electrical machinery

products has a linear part, for the region corresponding to higher values of $UV_{kk'j}/UV_{k'kj}$. Existing literature (e.g., [11]) points out that the scatter plot has a nonlinear part because of rather artificially set prices for lower value regions.

The crucial point is that since there is a linearity observed in the region corresponding to higher values of unit-price ratio, we cannot artificially set a cut-off level with proper theoretical justification. Only one point with the maximum horizontal value (in Figure 1) might be eliminated from calculation, since the corresponding dot is "far from" the straight line drawn. In other words, most data could be treated as "legitimate" or non-anomalous values. Also, since the unit-price ratio itself is used merely for the judgment of HIIT or VIIT, the "anomalous" value does not distort the computation result in a significant manner. In sum, most anomalous values or outliers cannot be distinguished from "normal" values.

4. Comparison between Trade Patterns in East Asia and the EU

Using the data of the PC-TAS we will compare IIT in East Asia with that in the EU. For the purpose of this study, East Asia includes China, the ASEAN-4 (Indonesia, Malaysia Thailand, Philippines), the NIE3 (Hong Kong, Korea, Singapore), and Japan. We will use the EU as a benchmark case for our analysis of East Asia. The results (Figures 2 and 3) show that both in East Asia, the GL index and VIIT share have been on an increasing trend, although in the case of the intra-East Asian trade the level of VIIT share is still low.

Figures 4 to 7 show the shares of the three trade types in intra-EU and intra-East Asian trade for each commodity category. The commodity classification we used is explained in the Appendix Table. These figures are simplex diagrams. A set of shares of the three trade types is expressed as one point in the diagram. The distance between this point and the horizontal line HIIT-VIIT denotes the share of OWT. Similarly, the distance between this point and the line OWT-VIIT denotes the share of HIIT. The starting point of each arrow corresponds to the value for the year 1996 and the end of the arrow corresponds to the value for 2000. Although the figures for East Asia are located towards the upper right in comparison with those for the EU, there is a similar pattern in terms of the differences between commodity groups. In both the regions, OWT dominates the trade in agricultural and mining products. The share of VIIT is relatively high in the trade in machinery. There also exist some differences between the EU and East Asia. In East Asia, the share of VIIT is exceptionally high in the trade in electrical machinery and general and precision machinery. We should note that in East Asia, export oriented FDI is most active in the production of these goods. In the EU, the shares of VIIT and HIIT are very high not only in the trade in this type of machinery but also in the trade in many other manufacturing products, such as chemical products, transportation machinery, and wood and paper products.

Let us next examine differences in IIT patterns among countries. Figures 4 and 5 show the shares of three trade types for each country. In the case of the EU, the most developed and large economies, such as Germany and France, have the highest shares of VIIT and HIIT. In the case of East Asia, there seems to be no simple country factor by which we can explain differences in IIT patterns among the countries, yet many developing countries are rapidly increasing their share of IIT. In the EU, the share of IIT has remained almost constant for most countries.

According to our calculations (Table 2), the share of vertical IIT in total intra-East Asian trade grew from 16.6% in 1996 to 23.7% in 2000, while that in total intra-EU trade increased only slightly

from 37.5% to 40.0% during the same period. The table also shows that in the case of intra-EU trade, the increase in the share of VIIT has been driven more by the composition change of the overall trade, whereas in the case of intra-East Asian trade, the increase in the overall share of VIIT has been attributable more to intra-industry increase of VIIT shares. This increase of VIIT shares in East Asia seems to be caused by the active foreign direct investment in the region undertaken by multinational corporations.

5. Conclusions

We investigated the recent change in trade patterns in East Asia and compared them with those in EU, using the HS 6-digit level data published by the United Nations. Specifically, we aimed to verify whether the intra-regional trade in East Asia is of an "inter-industry," "vertical intra-industry," or "horizontal intra-industry" nature. We also analyzed the role of FDI in the change of trade patterns. Our analysis reveals that, although still much lower than in the EU, intra-industry trade, and particularly vertical IIT, in East Asia has rapidly grown in importance in overall intra-regional trade. While for most EU countries, the share of IIT remained almost constant during the period from 1996 to 2000, it rapidly increased for East Asian countries.

Regarding the treatment of anomalous data (or outliers), there has been no theoretical justification upon which we can adopt a cut-off threshold. In practical terms, it would be necessary to set a sort of cut-off level for the benefit of time-series stability of trade indices, yet it seems to have no theoretical underpinnings, again. Further research effort would therefore be needed in this regard.